REMARKS/ARGUMENTS

Claims 1-6 are directed to a light metal hollow member prepared by extruding a light metal material, or a process or apparatus for producing the same. In the extrusion of a light metal hollow member using an extrusion die, the light metal may be divided and rejoined at the extrusion die. For example, an extrusion die such as that shown in Figure 6 divides a light metal, e.g., aluminum, billet at the bridge portion of the internal die 4a, and the divided metal portions are then welded or rejoined in the welding chamber 8 before being extruded through the gap between the bearings 7a and 7b. Such a die arrangement has the advantage that the bridge die has a life cycle longer than that of other hollow dies, but has the disadvantage that the strength of the welded portions may be inadequate (page 4, lines 14-18). This is because the metallurgical welding adhesion between the rejoined portions of the material may be imperfect (see paragraph bridging pages 3-4). Thus the use of such a die has been limited to certain materials (sentence bridging pages 4-5).

The present invention is based upon the novel recognition that the tensile strength of the welded portions of an extrudate which has been divided and rejoined can be raised as a function of the strain level applied to the material to be extruded after the material has been rejoined. More specifically, it has been found that the strain level applied to the light metal material after the joining/welding should be maintained at 1.8 or more in the process for extruding (page 6, lines 12-22). This strain level may be maintained by the design of the geometry of the welding chamber relative to the cross sectional area of the product to be extruded (paragraph bridging pp. 12-13).

Evidence of improved tensile strength resulting from the invention is found in Figure 4 and Tables 1 and 2 on page 15 of the specification. As is evident from Figure 4, it has been found that the tensile strength at the welding portion rises to approach the tensile strength at the bearing portion of the extrusion as the strain level rises. According to Table 2, this tensile

strength is judged to be good for strain levels of 1.8 or more, but is judged to be inadequate for the lower strain levels of Comparative Samples 1-4 and 11.

In view of the above, it may be appreciated that the recitation in Claim 1 that in a process including a step of dividing and rejoining a light-metal material, and extruding the light-metal material after rejoining, maintaining a strain level applied to the light-metal material after joining/welding at 1.8 or more provides unexpected results. Similarly, Claim 4 recites that a hollow extrusion die is designed so that a strain level applied to a light-metal material after joining/welding can be maintained at 1.8 or more. Claim 6 recites a light-metal hollow member prepared by maintaining a strain level applied to the light-metal material after joining/welding at 1.8 or more and performing the extrusion, wherein the strength of the welding portions is 90% or more of that of bearing portions. In each case, a strain level applied to a divided light-metal material after joining/welding is maintained at 1.8 or more which, as evidenced in the specification, provides a high strength at the welded portions.

Claims 1-6 were rejected under 35 U.S.C. §103 as being obvious over U.S. patent 3,520,168 (Braeuninger) in view of U.S. patent 6,233,500 (Malas et al.). However this rejection is respectfully traversed.

Braeuninger discloses a porthole die in which the material to be extruded is divided at the feeder holes 17 and then permitted to be rejoined at the areas 14 of the die plate 10 before being extruded through the die orifice 13. Braeuninger is concerned with possible cracking of the mandrel and mandrel support, or unduly large press capacity required for the functioning of the die, due to high pressing pressures (column 3, lines 22-36). The invention in Braeuninger is "based on the discovery that" a certain ratio of the cross sectional area of the feeder holes 17 to the cross sectional area of the die orifice 13, and the ratio of the cross sectional area of the billet to the cross section area of the feeder holes will reduce the feed pressure and cracking of the mandrel (column 4, lines 15-34).

Braeuninger is thus primarily concerned with the role of the feeder hole geometry in reducing the press pressure required for extrusion in a porthole die. (It is true that a better weld for the rejoined streams of metal is mentioned at lines 37-41 of col. 3, but this is evidently considered to be a by–product of reduced press pressures). The role of the strain level of the material after rejoining is not expressly discussed but, as noted above, it is a function of the ratio of the geometry of the welding chamber relative to the cross sectional area of the product to be extruded, and not the geometry of the feeder holes which are located upstream of the location of the rejoinder of the divided streams.

Braeuninger sheds light on this at lines 28-49 of col. 5. According to this description, changes in the geometry of the feeder holes have little effect on the geometry of the welding chamber (col. 5, lines 38-41). Thus they would be expected to have little effect on the strain level of the material after rejoining.

On the other hand, Braeuninger states, at lines 30-35 of col. 5: "The [press] pressure so required is related to the total area [of the welding chamber] to the cross-sectional area of the shape being extruded." This indicates that the press pressure is related to the geometry of those elements that determine the strain level. However, *since the press pressure is to be reduced in Braeuninger, this teaches that the strain level must be kept as low as possible –* the opposite of the invention.

Malas et al. is directed to a process for optimizing the microstructure development during hot metal working. It uses state-space material behavior models and hot deformation process models for calculating optimum strain, strain rate and temperature trajectories for processing the material in order to control the microstructure. Figures 4a-4c show that the strain can be as high as about 1.8.

According to the Office Action, it would have been obvious for one skilled in the art to have provided a strain level of 1.8 or more in Braeuninger "to develop material

microstructural considerations when calculating the feeder hole and die geometry in order to produce strong welds." This is respectfully traversed, however, since it is contrary to the teachings of Braeuninger and since the combination of Braeuninger and Malas et al. would not have been obvious to one skilled in the art.

Malas et al. does not disclose the use of a feeder hole die, and so the teachings thereof are not relevant to extruding via feeder hole type dies. It is well established that obviousness can only be established by reliance on prior art which is the same or analogous prior art to that of the invention, wherein analogous prior art is that which presents problems which are reasonably pertinent to those confronting the would-be inventor. M.P.E.P. §2141.01(a). In view of the fact that Malas et al. is not directed to a feeder hole die, it does not present the problems arising where extrusion is provided by dividing and then rejoining the material to be extruded, e.g., deterioration of the mandrel or poor strength at the weld areas. It may therefore be appreciated that Malas et al. is not analogous prior art and so cannot be relied upon to establish a *prima facie* case of obviousness.

In any case, Braeuninger teaches that the press pressure is tied to the geometry of the elements which determine the strain level of the material after rejoining. Braeuninger thus teaches away from the invention – one skilled in the art would not have found it obvious to have selected a die geometry in Braeuninger which requires an increased press pressure, regardless of the teachings of Malas et al. This is strong evidence of the unobviousness of the claimed invention. MPEP § 2141.02; MPEP § 2145(X)(D)(2). Accordingly, Claims 1-2 and 4-6 define over this prior art.

Claim 3 recites the steps of examining a correlation between the strain level applied to a light-metal material after joining/welding and the welding strength of the welding portions of a product after extrusion; determining a strain level corresponding to a target welding strength as a target strain level on the basis of the correlation; and maintaining the strain level

during the extrusion of the light-metal material. Since the specification indicates that the strain level providing a high welding strength must itself be high, which is contrary to the teachings of Braeuninger, Claim 3 is also unobvious from the applied prior art.

Applicants therefore believe that the present application is in a condition for allowance and respectfully solicit an early notice of allowability.

Respectfully submitted,

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